Concept Document of the Repository-Based Software Engineering Program:

A Constructive Appraisal

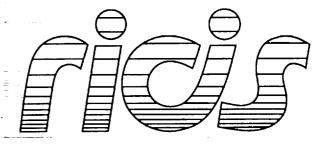
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INTERIM REPORT

RICIS Preface

This research was conducted under auspices of the Research Institute for Computing and Information Systems by Applied Expertise, Inc. Dr. E. T. Dickerson served as RICIS research coordinator.

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The views and conclusions contained in this report are those of the author and should not be interpreted as representative of the official policies, either express or implied, of UHCL, RICIS, NASA or the United States Government.

CONCEPT DOCUMENT of the REPOSITORY-BASED SOFTWARE ENGINEERING PROGRAM:

A CONSTRUCTIVE APPRAISAL

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I. OVERVIEW

Applied Expertise, Inc. was tasked to provide a constructive appraisal of the Concept Document of the Repository-Based Software Engineering Program (December 11, 1991) by the Level 3 Program Manager. The following is a response to this request.

Introduction

The Concept Document is designed to provide an overview of the Repository-Based Software Engineering (RBSE) Program. The Document should be brief and provide the context for reading subsequent requirements and product specifications. That is, all requirements to be developed should be traceable to the Concept Document.

Applied Expertise's analysis of the Document was directed toward assuring that: (i) the Executive Summary provides a clear, concise, and comprehensive overview of the Concept (rewrite as necessary), (ii) the sections of the Document make best use of the NASA "Data Item Description" for concept documents, (iii) the information contained in the Document provides a foundation for subsequent requirements, and (iv) the document adequately:

- · identifies the problem being addressed,
- · articulates RBSE's specific role,
- · specifies the unique aspects of the program, and
- identifies the nature and extent of the program's users.

Methodology and Scope

Our approach to the analysis included:

- An appraisal of the Document with a view toward evaluating its organization and identifying
 pertinent information that is missing or in need of clarification. (See Exhibit A for
 Organization Template)
- A section-by-section analysis of the Document to assure that each section tracks with NASA
 guidelines and contains the information considered most relevant to providing the reader with
 a clear understanding of the problem being addressed by the Program and a clear description
 of the program's purposes, goals, objectives, benefits and limitations.
- A restructuring of the Executive Summary with a view toward providing a clear, concise and comprehensive presentation for the Executive reader. (See Exhibit B for Revised Preliminary Executive Summary)

The analysis was limited to the Concept Document dated December 11, 1991, and did not include discussions with those who prepared the Document or review of all the references and other materials used by the Document originators.

Major Concerns

The Concept Document follows the broad outline presented in NASA-DID-P100, Concept Data Item Description. On the basis of our analysis, however, we believe the Document is too fragmented and needs major organizational restructuring within the NASA guidelines. We also believe the Document should:

- 1. Specifically define and bound the problem that RBSE seeks to solve and delineate which parts of the problem RBSE is addressing.
- 2. Clarify RBSE's functions in terms of (i) operations, (ii) system development, (iii) research and how these functions interrelate. Moreover, the document should specify the types of products the program will deliver to customers.
- 3. Carve out the program's special niche by identifying the specific customer groups RBSE will serve. For example, automotive, manufacturing, and avionics control systems are all potential customers for safety-critical software solutions.
- 4. Make a clearer distinction between what the repository is currently doing and what more it will do when the RBSE program is completed. As presented, the document does not provide any illustrations demonstrating that successes achieved under the existing repository provide a rationale for continuation and expansion.
- 5. Provide evidence or documentation that substantiates or gives credibility to the benefits asserted in the Document. We need to more clearly demonstrate that the costs to be incurred in completing RBSE will be commensurate with the benefits to be achieved.
- 6. Reflect quantified measures of current use and projected use. This would further demonstrate the growing importance and reliance on reuse.
- 7. Address the issue of self-sufficiency.

Identification of problem areas, organization restructuring and suggested replacement text are described in greater detail in the following Section-by-Section Analysis.

II. SECTION-BY-SECTION ANALYSIS

This section-by-section analysis of the Concept Document is designed to describe the purpose of each major section of the Document, provide an appraisal of the organization and information included in each section and subsection and, where appropriate, provide examples of suggested replacement text.

Section 1.0 Introduction

Purpose - This section of the Concept Document is intended to provide the reader with an identification of the Document, its purposes, scope, status and organization.

Appraisal - Our analysis shows that Section 1.0 of the Concept Document could be further improved by presenting the required information in a more organized and descriptive manner.

Replacement Text - To illustrate what we believe to be a more comprehensive introduction section, we have completely revised Section 1.0 for your consideration. (See Exhibit C, "Suggested Introduction")

Section 2.0 Related Documentation

Purpose - This section should provide identification of and reference to laws, regulations, standards and other informational documents providing background, historical perspective and related technical developments. The section's subsections should reflect applicable and informational documents.

Appraisal - The references included in this section should be reviewed to ensure they are current. For example, the current version of the NASA Software Documentation Standard Software Engineering Program (SMAP) is not referenced. Also, any additional references used to revise the Concept Document should be added to this section.

Replacement Text - None suggested

Section 3.0 Definition of the RBSE Program

Purpose - This section should (i) define the Program, identify the problem to be resolved, and provide necessary background information; (ii) articulate long-term goals, specific objectives, and describe benefits; (iii) identify the unique aspects of the Program and Program activities; (iv) define the approach and implementation of the Program; and describe Program policies.

Appraisal - We believe this section needs major revision. It does not distinctly set off the problem, or make a clear distinction between the current and proposed RBSE. Background information is discussed throughout the section without any clear focus. The section does not provide sufficient information about what is unique about RBSE or provide the reader with a clear statement of the specific objectives of RBSE. Also, there is no development of tangible benefits to be derived from RBSE. In addition, this section does not logically define the Program or provide sufficient information on the research, systems development, or organizational activities of the Program and their interrelationships. Exhibit A of this analysis suggests an overall organizational template for a revised Concept Document. Section 3.0 of the template categorizes by subsections the types of information we believe should be included in the section.

The following highlights some specific problems:

- 1. The first paragraph under Section 3.0 starts by describing the Concept Document. This was done in Section 1.0 Introduction and need not be repeated. See suggested language under replacement text.
- 2. Subsection 3.1 does not make a clear statement about the purpose and scope of the program. See suggested language under replacement text. Also, the scope of the program needs better identification. This can be accomplished by abstracting and condensing the bulleted information appearing on page 3-1 of the Concept Document.
- 3. The bulleted information appearing under subsection 3.1 on page 3-1 is repeated verbatim under Section 3-2 Goals and Objectives. This is unnecessary redundancy and appears to be presented as both Program scope and objectives.
- 4. The current Document does not provide sufficient information about the different elements of the problem and those aspects to be addressed by RBSE. We suggest this information be developed under a separate side caption 3.1.1 Problem Statement. See suggested language for introducing the problem.
- 5. Currently, background information is spread throughout the Concept Document. We believe it needs to be pulled together in one place. We suggest a background section be developed under a separate Subsection 3.1.2 to provide the reader with a brief statement about the role of the software industry and an overview of the history and current status of the reuse library. This background section should reflect:
 - a. Role of the Software Industry Software plays an expanding and an increasingly critical role in the safety, quality and competitiveness of U.S. products and services.....etc.

- b. Project History Members of the RBSE team developed and currently operate a prototype repository library.....etc.
- c. Current Status The status of the current library etc. provides a foundation for the RBSE......etc.
- 6. Section 3.2 covering goals and objectives needs to provide a clearer definition of the objectives of RBSE. The section provides the reader with a picture of the long-term goals but does not clearly identify the specific objectives. As presented, the long-term goals would be difficult to measure and attribute to RBSE, whereas specific objectives would be more measurable. We believe the Document could be improved by identifying and describing the specific goals of RBSE. We suggest it be reorganized by developing a number of subsections along the following lines:
 - a. 3.2.1 Long-Term Goals The information relating to the improvement of U.S. economic growth, productivity, and competitiveness should be discussed in this subsection. Specifically, the goal of improving software practices among RBSE's target customers should be discussed here.
 - b. 3.2.2 Specific Objectives The specific objectives of RBSE should be defined and described in this section.
 - c. 3.2.3 Program Benefits and Measurements This subsection should describe the benefits of RBSE. To the extent practical these benefits should be presented in terms of dollar savings. There are a number of studies that contain data relating to savings that can be attributed to reuse. One such example is NASA Software Engineering Laboratory's "Experiments in Software Engineering Technology: Recent Studies in the SEL (1990-1991)." In addition, the Document should describe the process to be used to measure the benefits derived from achieving Program results.
- 7. We believe Section 3.3 Program Description should be reorganized to provide those reviewing and approving the Document with a clearer picture of RBSE and what the Program is to accomplish. Also, this section should describe the unique role of RBSE. To accomplish this, we suggest the Program Description section be segregated into a number of subsections, as follows:
 - a. 3.3.1 The Unique Role of RBSE This subsection should describe the overall solution to software engineering problems and the unique role RBSE will play in contributing to the solution of this problem. Those aspects of the problem being addressed by RBSE should be highlighted. We suggest this can be done by developing a graphic. For

example, graphics might be used to highlight the different aspects of the problem and pinpoint the areas RBSE will address (while illustrating roles played by other repository programs).

- b. 3.3.2 Research Activities This subsection should be developed to describe the research activities of the RBSE and discuss their benefits to RBSE and its goals.
- c. 3.3.3 Systems Development This subsection should identify and describe the improvements to the repository to be developed under the Program.
- d. 3.3.4 Operation This subsection should describe RBSE operation. For example, an expansion of the information described in 6.4 Personnel would fit into this section.
- e. 3.3.5 Interoperability This subsection should discuss interoperability as a method for cost-effectively broadening RBSE's customer and supplier base. It should specifically describe the Reuse Library Interoperability Group (RIG) and outline RBSE's activities with respect to interoperability.
- f. 3.3.6 Total Quality Management (TQM) This subsection should discuss TQM as a cornerstone of the Program's focus, impact, value to its customers and efficiency. It should affirm the Program's intent to refine and achieve specific, measurable goals.
- g. 3.3.7 Cost Recovery This subsection should address the issue of cost recovery.

In summary, we are suggesting that Section 3.0 be reorganized and that additional information as discussed above be included in the section. We suggest the reorganization follow the structure detailed in Exhibit A, "Organization Template."

Replacement Text - The following represents examples of the replacement text for selected areas discussed above.

3.0 DEFINITION OF THE REPOSITORY-BASED SOFTWARE ENGINEERING (RBSE) PROGRAM (replacement text)

RBSE is a NASA program that encompasses a public-domain life-cycle repository designed to collect, store, and distribute a unique set of reusable products, processes, interfaces, and information spanning the software engineering life cycle. RBSE will also maintain standards, practices and guidelines relating to life-cycle repositories and to repository-based approaches to software engineering. Through targeted research, the Program fills in critical technology gaps.

3.1 Purpose and Scope

Purpose - RBSE is a research and development program designed to contribute to the mainstream adoption of software reuse in government, industry, and academia. Its broad purpose is to provide a repository that nourishes the selection, adaptation, and reuse of existing components and that promotes common practices and standards.

3.1.1 Problem Statement

Current software development practices need the clarity, consistency, and predictability that other, more mature engineering disciplines provide as a matter of course. For example, buildings, bridges and even computer hardware are built by using common models, practices, guidelines, interfaces, and off-the-shelf parts. These elements, taken for granted in other engineering disciplines, are in their infancy for software engineering practice. As a result, opportunities to improve the quality, safety, and rapid tailorability of software is lost. Moreover, costs are increased and the competitiveness of U.S. products and services are diminished.

Section 4.0 User Definition

Purpose - This section identifies specific users of RBSE, the functional capabilities and products required by those users, and the unique niche established by the program for specific types of users.

Appraisal - This section needs to be more specific concerning who the users are and how they will be using the system. The descriptions used in this section should correspond with the scenarios presented in Section 6.0 Operational Scenarios. The section could be made much clearer if segregated into different sections as follows:

- a. 4.1 User Category See suggested replacement text below.
- b. 4.2 Target Customers This subsection could be used to elaborate on the special relationship RBSE intends to develop and maintain with target industries, particularly those heavily involved in safety-critical systems, and commercial aerospace. This subsection should also address the demands of these target customers.
- c. 4.3 Customer Use of the Repository This section should incorporate the information reflected in subsection 6.5 captioned equipment and such other information describing how RBSE customers will use the system. Section 6.5 describes how users access the system and should be deleted from Section 6.0.

Replacement Text - The following represents examples of replacement text:

- 4.1 User Categories The RBSE library will be available to three broad categories of users. They are submitters, reusers, and repository staff.
- Submitters include government and commercial software developers, authors, conference organizers, and marketers. The submitter would provide the library a set of artifacts for qualification and admission into the life-cycle repository. (See Scenario 6.1 Submission to the Repository)
- Reusers include software engineers, system architects, managers, educators, authors, and conference organizers. The reuser locates and retrieves components that can be used and/or adapted for use in the development of a new software engineering system. (See Scenario 6.2 Reuse of Repository Contents)
- Repository staff includes the RBSE operations and support staff. Staff will acquire, classify, qualify, and maintain the repository contents and organization. (See Scenario 6.3 Repository Maintenance)

Section 5.0 Capabilities and Characteristics

Purpose - This section presents the general capabilities and resources of RBSE and projects the expected usage of the Life-Cycle Repository by the different classes of users.

Appraisal - This section should include and expand upon the comments made in Section 4.0 with regard to the unique niche to be addressed by RBSE.

Replacement Text - None Suggested

Section 6.0 Operational Scenarios

Purpose - This section presents a number of scenarios illustrating user interaction with the repository.

Appraisal - This section should be modified by moving Section 6.4 and including the information under Subsection 3.3.3 Operations. Also, Section 6.5 should be moved and included under proposed section 4.3 Customer Use of the Repository.

Replacement Text - None Suggested

Section 7.0 Abbreviations, Acronyms and Definitions

Purpose - This section contains an alphabetized list of definitions for abbreviations, acronyms, and special or unusual terms used in the Document.

Appraisal - The Document does not include a Section 7.0 but does have a page dealing with acronyms. We believe a section should be added that covers abbreviations, acronyms, and definitions. For example, reuse as discussed within the framework of RBSE may be somewhat narrower than reuse discussed by others -- that is, off-the-shelf commercially available components.

Replacement Text - None Suggested

Appendices

Purpose - To provide information relating to the Program being discussed in the Concept Document.

Appraisal - Appendix information should be informative and relevant but not essential to an understanding of the Concept Document. Any essential information included in the appendices should be extracted and included where appropriate in the body of the Document.

Replacement Text - None suggested

EXHIBIT A - ORGANIZATION TEMPLATE

1 INTRODUCTION

- 1.1 Identification
- 1.2 Scope
- 1.3 Purpose and Objectives
- 1.4 Status
- 1.5 Organization

2 Related Documentation

- 2.1 Applicable Documents
- 2.2 Informational Documents

3 Definition of the Repository-Based Software Engineering (RBSE) Program

- 3.1 Purpose and Scope
 - 3.1.1 Problem Statement
 - 3.1.2 Background
- 3.2 Goals and Objectives
 - 3.2.1 Long-Term Goals
 - 3.2.2 Specific Objectives
 - 3.2.3 Program Benefits and Measurements
- 3.3 Program Description
 - 3.3.1 The Unique Role of RBSE
 - 3.3.2 Research Activities
 - 3.3.3 Systems Development
 - 3.3.4 Operations
 - 3.3.5 Interoperability
 - 3.3.6 Total Quality Management
 - 3.3.7 Cost Recovery
- 3.4 Policies

4 User Definition

- 4.1 User Categories
- 4.2 Target Customers
- 4.3 Customer Use of Repository

- 5 Capabilities and Characteristics
 - 5.1 Program Capabilities5.2 Characteristics
- 6 Operational Scenarios
 - 6.1 Scenario #1 Repository Submissions
 - 6.2 Scenario #2 Reuse of Repository Contents
 - 6.3 Scenario #3 Repository Maintenance
- 7 Definitions, Acronyms, and References
 - 7.1 Definitions
 - 7.2 Acronyms
 - 7.3 References

EXHIBIT B - SUGGESTED EXECUTIVE SUMMARY (preliminary)

THE PROBLEM

Software plays an expanding and increasingly critical role in the safety, quality and competitiveness of U.S. products and services. Despite its importance, software engineering and development practices lack the clarity, consistency, and predictability provided by more mature engineering disciplines. For example, engineering practices for erecting, constructing, and manufacturing buildings, bridges and computer hardware include the reuse of common models, guidelines, interfaces, and off-the-shelf components. These elements, taken for granted in other engineering disciplines, are not consistently applied in software development. Today's software is commonly built haphazardly. All too often, efforts to improve the situation through reusing what exists, or engineering products for later reuse, are dropped to meet schedule or budget pressure.

As a result, a disturbingly high proportion of software continues to be brittle, inflexible and hard to maintain more than most of the time. Opportunities are lost to improve the quality, safety, and rapid tailorability of software. Perhaps more importantly, costs and risks to the taxpayer, consumer and shareholder are inflated and the competitiveness of U.S. products and services is diminished.

DEFINITION, GOALS AND OBJECTIVES

NASA's Repository-Based Software Engineering (RBSE) program comprises three areas: (i) operation of a national software life-cycle repository to promote software reuse, (ii) system development to support this operation and (iii) research to increase Program impact. The goal of this program is to improve software practices among RBSE's target customers -- software developers in key segments of U.S. industry -- so their software engineering efforts parallel the clarity, consistency and predictability of other engineering disciplines. As a result, these customers will be able to develop better and safer software that is produced faster and at lower cost.

Software reuse has been recognized by software practitioners as well as policy makers as a key factor in improving product quality and competitiveness. There is growing evidence that products that are engineered for reuse are more reliable, more maintainable and of higher quality than conventional software products. RBSE, through its strategy of cooperative participation in national programs designed to encourage the mainstream adoption of software reuse, will make a significant contribution toward this goal by --

- delivering and supporting a robust set of reuse products geared to help customers incorporate effective reuse into the way their organizations do business. (Section 3.3.2)
- improving the effectiveness of the repository (the product delivery mechanism) through application of research results, customer feedback and off-the-shelf software. (Section 3.3.3)
- filling in critical technology gaps through research, such as methods for organizing and managing software artifacts and process models. (Section 3.3.4)
- broadening the customer and supplier base by supporting interoperability. (Section 3.3.5)

RBSE was the first program to evolve the concept of life-cycle repository-based engineering, which is now being implemented by a number of organizations in government and industry. This multiplicity, when balanced with cooperation, is critical while reuse matures in technology and practice. It allows each of the individual reuse libraries to customize its technology and services to the needs of its customers. Each repository, in developing creative approaches to practical problems, can benefit from the advances and inventiveness of other repositories. To this end, the Reuse Library Interoperability Group (RIG) develops consensual standards for the interoperability of software reuse libraries. RBSE participates in the RIG efforts to make interoperability a reality.

No matter how sophisticated the repository becomes, qualified repository staff who are willing and able to help their customers will mean the difference between mainstream and casual use by major organizations. Similarly, a program-wide commitment to quality—the measured process of continuously providing customers with what they expect and need most, ever more efficiently and effectively—is key to success in any and all Program objectives and goals. (Section 3.3.6)

USERS

In order to get the greatest leverage from its efforts, RBSE seeks to develop a loyal customer base within two overlapping customer groups. Those groups are (i) builders of software-intensive, safety-critical systems, including manufacturing, railroads, medical, nuclear and hazardous material, and (ii) NASA and civilian aerospace. RBSE is uniquely positioned to become the supplier of choice for NASA-developed software artifacts and related documents.

IMPACT

There are three distinguishing features of the RBSE program. It is committed (i) to becoming the supplier of choice for reusable artifacts from civilian aerospace application domains, (ii) to improving software-intensive, safety-critical systems and (iii) to introducing reuse into all phases of the software life cycle.

Industry studies indicate that five- to ten-year productivity gains of over 25 percent, reliability improvements of 300 percent and 60 percent reductions in the time it takes to deliver a product are achievable through software engineering and reuse. RBSE has targeted key, but limited, segments of U.S. industry where the U.S. maintains a competitive edge and from which technological successes are likely to spread quickly. RBSE, in concert with other reuse and software engineering initiatives, can effect broad and positive changes in the way U.S. industry develops software.

In sum, software theory and practice lack several essential elements common to more mature fields of engineering. By building a strong repository-based program, RBSE will promote the reuse of common models, standards, practices, guidelines and off-the-shelf components. The success of RBSE and related programs can transform software development and support from a cottage industry to an efficient, effective, quality-driven industrial process fostering needed improvements in U.S. productivity, economic growth, and competitiveness.

EXHIBIT C - SUGGESTED INTRODUCTION

1.0 INTRODUCTION

- 1.1 <u>Identification</u> This is the Concept Document for a Repository-Based Software Engineering (RBSE) Program. The Document provides an overview of RBSE and creates the foundation for establishing the Requirements Section of the Program's specifications.
- 1.2 <u>Scope</u> The Document (i) identifies problems to be addressed and describes the mission, goals, and objectives of RBSE; (ii) discusses the relationship and coordination with other related activities, (iii) details the general approach toward resolving the problems identified; and (iv) identifies intended users and other beneficiaries.
- 1.3 <u>Purpose and Objectives</u> The Document provides the foundation for developing RBSE user and system requirements. The Program Management Plan to be developed from the Document will discuss how resources are to be organized and applied to achieve the mission, goals, and objectives of RBSE.
- 1.4 <u>Status</u> It is an active Document subject to review and updating to identify problems, implement improvements and reflect lessons learned. The scope of the Document will be periodically changed as appropriate and necessary.
- 1.5 <u>Organization</u> The Document is comprised of six sections including this introduction section. The other sections are:
 - 2.0 <u>Related Documentation</u> This section provides identification of and reference to laws, regulations, standards and other informational documents providing background, historical perspective and related technical developments.
 - 3.0 <u>Definition of the RBSE Program</u> This section provides Program background; establishes motivation and problem identification; identifies products, services, and benefits; and defines the approach and implementation of the Program.
 - 4.0 <u>User Definition</u> This section identifies specific users of RBSE, the functional
 capabilities and products required by those users, and the unique niche established by
 the program for specific types of users.

- 5.0 <u>Capabilities and Characteristics</u> This section presents the general capabilities and resources of RBSE and projects the expected usage of the Life Cycle Repository by the different classes of users.
- 6.0 Operational Scenarios This section presents a number of scenarios illustrating user interaction with the repository.
- 7.0 <u>Abbreviations</u>, <u>Acronyms and Glossary</u> This section contains an alphabetized list of definitions for abbreviations, acronyms, and special or unusual terms used in the Document.